Adoption of environmental friendly agricultural practices : impact of environmental benefit incentive program in Costa Rica

A. Lamour[a], JF Le Coq[a,c], M. Bonin[b,c]

a : Centre de Cooperation International en Recherche Agronomique pour le Développement (CIRAD) - UMR ART-Dev;

b: CIRAD – UMR Tetis

c: Universidad Nacional de Costa Rica (UNA) – CINPE

Communication at the ISEE conference,
Reykjavík , August 13th-15th, 2014

Context and justification

- Raise of MBI including PES / AEM in agriculture
  - What impact regarding change in practices and ES provision ?
  - ➔ Lack of work applying modern methods of causal inference to environmental economics (Greenstone and Gayer, 2009)
- Environmental Benefit Compensation (RBA) in Costa Rica
  - 2006-2010: Interamerican Development Bank funds (USD 17,6 million for 4 years)
  - 2010-…: National budget funding (renewed thanks to a questionable evaluation)
  - Designed and administrated by the extension services of Ministry of Agriculture
  - Double aim: increase in productivity + improvement in water and soil quality
  - Direct incentive to farmers' "environmental-friendly" investments
    - List of 81 eligible technology (mainly sector-specific)
    - 4 classes of investment according to environmental externality, collective interest and implementation, and type of pay-off (from 20 to 30% of the total cost excluding labour costs)
    - Only members of farmers organizations are eligible
    - Conditional payment (expost)
  - Two main sectors : Livestock production (investment at farm level) and coffee sector (coffee processing at cooperative level)

Research questions and hypothesis

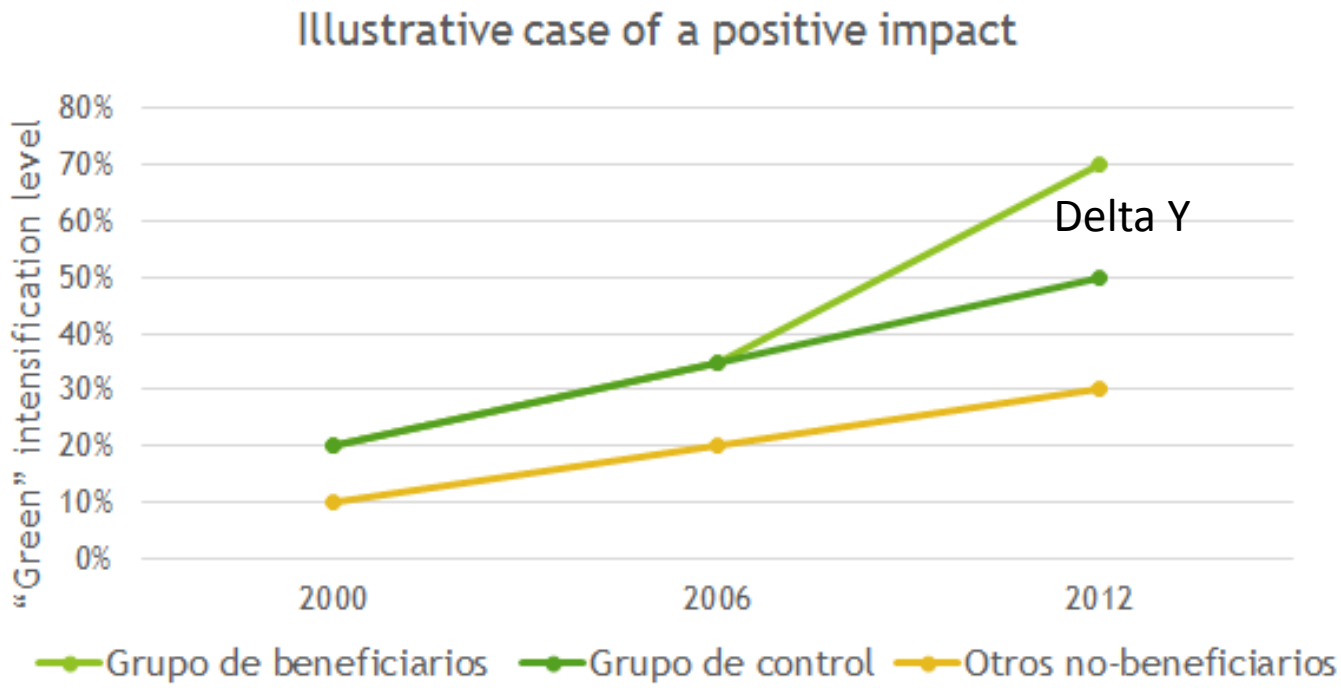
- Main research questions
  - Do the RBA have an impact the investment toward a adoption of greener practices ?
  - Do the RBA impact green intensification level and ES provision ?
- Hypothesis
  - RBA have an influence on investment enabling green intensification process
  - RBA have influence on level of intensification and ES provision

Concept and methodology (1)

Impact evaluation principle

- Program intervention: voucher/subsidy to reduce investment costs in “green” technologies to enable constraint farmers to implement it

=> What would the beneficiaries have done if they would not have received RBA?
=> Windfall effect (for non-constrained beneficiaries) or additional investment?



Concept and methodology (2)

Difference-in-difference method

- Difference-in-difference = combination between before/after and with/without situation, in order to measure RBA net impact on the treated population (=Average Treatment effect on the Treated)
  - $\Rightarrow$ control for time-unvarying observed and unobserved heterogeneity (dynamism, managerial abilities)

- Counterfactual / control group choice:
  - $\Rightarrow$ Recent participants show willingness to enter the program so they are likely to be similar to the past beneficiaries (pipe-line assumption)
  - $\Rightarrow$ Parallel trends between the recent beneficiaries' group and the treated group if it would have not received RBA incentive
  - $\Rightarrow$ No anticipation effect because the program is not well-known, participation depends on the reception of the information (SUTVA)

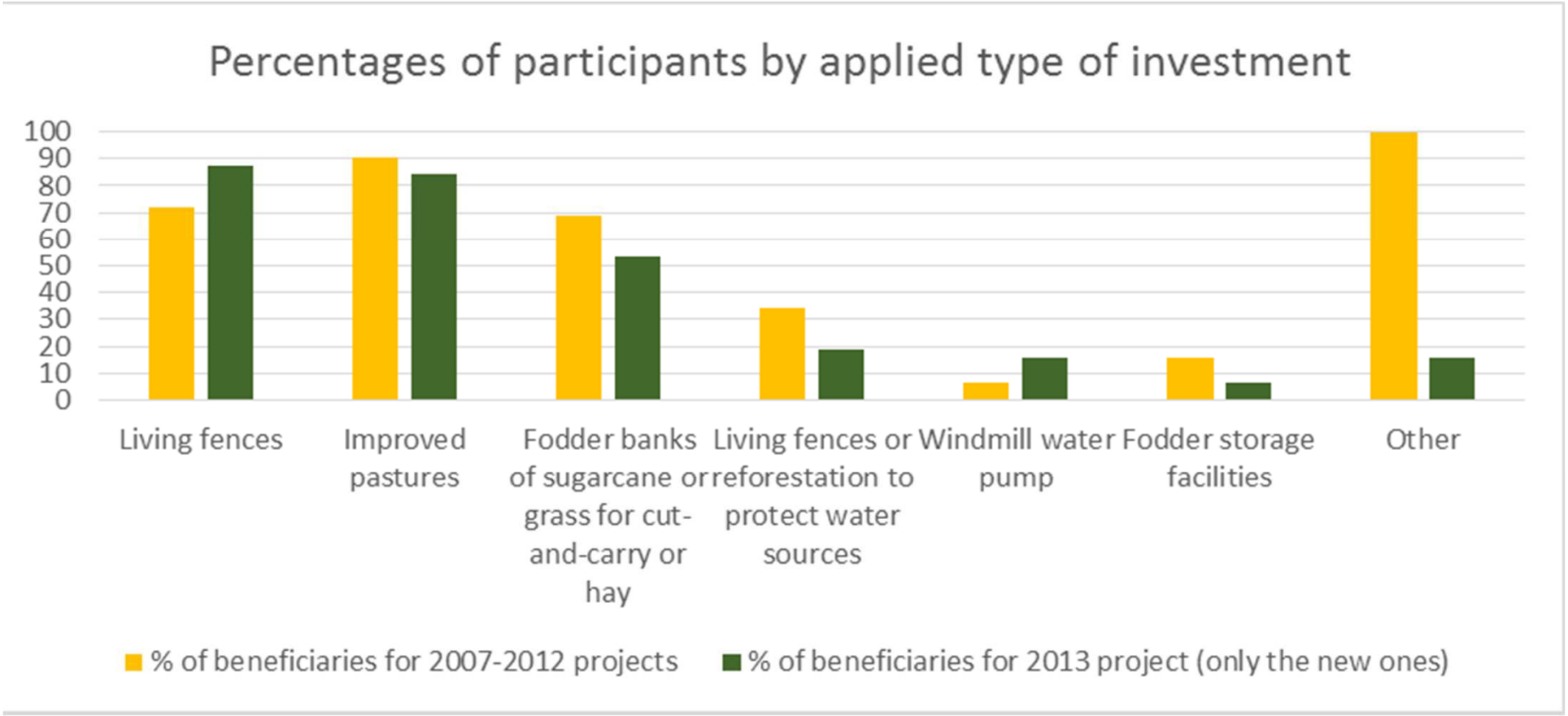
Material

- Case of North of Guanacaste region
  - Dry area – Water issue
  - Livestock extensive raising
  - Main sub sector and area for RBA use

- A Data base of RBA project demand (from Min Agri)
- Household Survey (in march – may 2013)
  - 63 households random from RBA database
    - 32 beneficiaries in 2007/2012 (treated group)
    - 31 applying to RBA in 2013 (control group)
  - 4 elements :
    - farm layout evolution (mapping) / land use evolution 2006-2012
    - Farm management and assets
    - Resource management
    - Socio economic characteristics

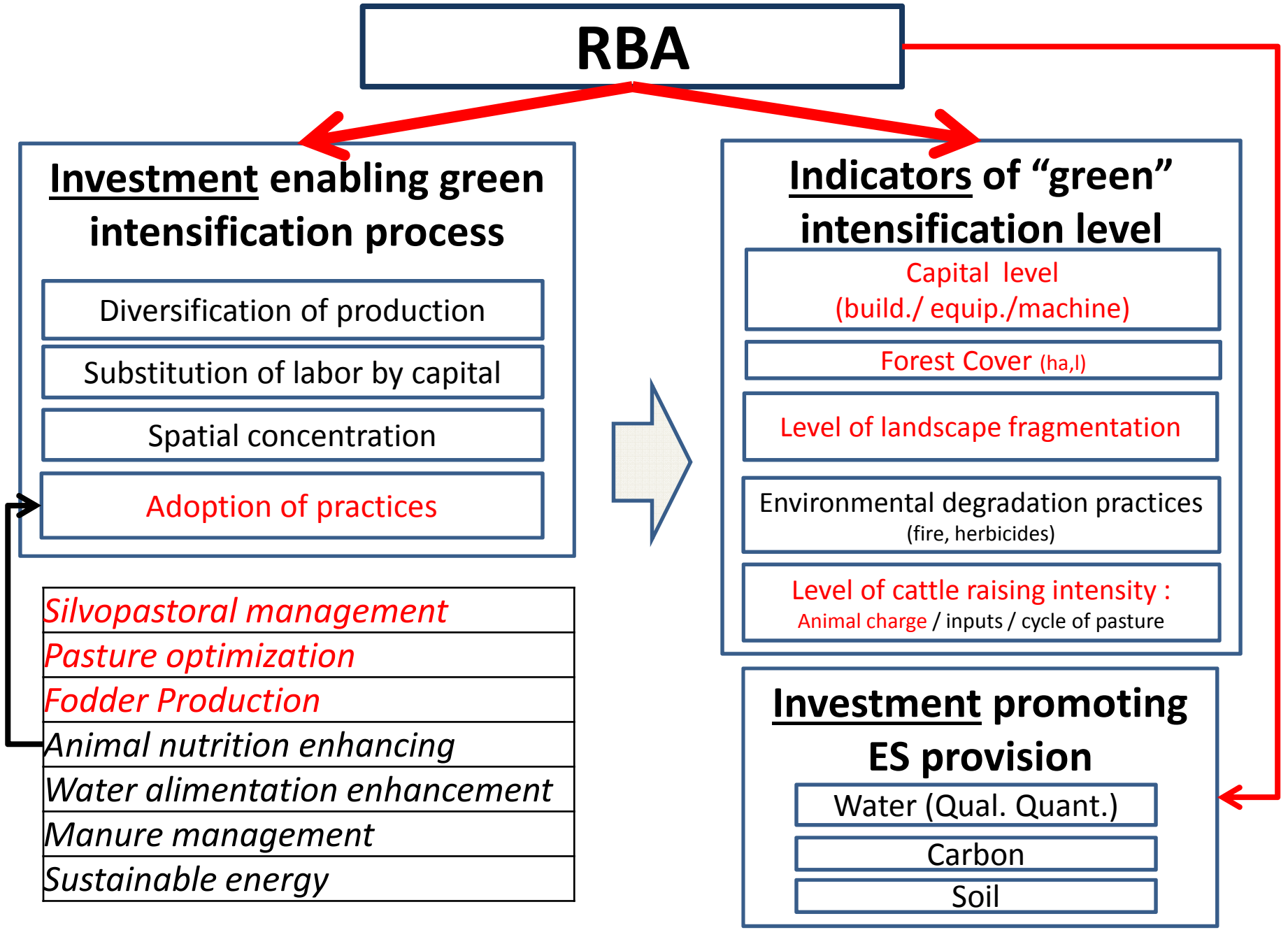
Sample description

What does sampled RBA participants apply for?



Source: Projects database (MAG) ; estimated costs excluding labor costs

Expected effect on livestock farming and ES



Analytical methods

- Participation variable: dummy variable (1 for 2007-2012 projects beneficiaries / 0 for 2013 project participants)
  - Sub-samples: participation limited to the specific asset studied (excluding the other 2007-2012 projects beneficiaries)
- Outcome variables:
  1) Eligible assets by “green” intensification practice components
  2) General indicators of “green” intensification
- Control variables: time-variant determinants of investment/practice choices
  - Income shifters: family off-farm work (***lingroff)***, social transfers (***ingrgob)***
  - Consumption shifters: family size (***lhht)***, age structure (***lmen12, lmay60)***
  - Other observed preference shifters: own farm size (***larea_prop~p)***
- Estimator: fixed-effect estimator (within)

Results

1) Average treatment effect on the treated: investment in eligible assets

	Sample	Asset specific sub-sample		Whole sample	
	Model	Without control	With control	Without control	With control
Silvopastoral management					
PCA index on living fences (m) + living fences or reforestation to protect water sources (0/1) + area of high tree density pastures (Ha) + area recently planted with trees (Ha)	*Coefficient **RBA***	**0,0915**			**-0,24**
	Robust standard error	0,1097			0,36
	p-value for joint significativity (F test)	0,41			0,53
Living fences (m)	*Coefficient **RBA***	**372,22***			**-394,32**
	Robust standard error	185,79			511,76
	p-value (F test)	0,05 (*)			0,15
Pasture optimization					
Improved pasture (Ha)	*Coefficient **RBA***	**8,28*** **			**-0,195**
	Robust standard error	2,96			6,98
	p-value (F test)	0,01 (**)			0,00 (***)
Fodder production					
PCA index on fodder shed (m²) + fodder bank of sugarcane and grass (Ha) + silo (m3) + tree/shrub fodder bank (Ha) + forage mincer (number)	*Coefficient **RBA***	**0**			**218**
	Robust standard error				208
	p-value for joint significativity (F test)	0			(***)
Fodder bank of sugarcane and grass (Ha)	*Coefficient **RBA***	**0,639****			**-0,525**
	Robust standard error	0,263			0,902
	p-value (F test)	0,02 (**)			0,35

no confident model

Confident model but no robust coefficient

Confident model but no robust coefficient

Confident model and robust coeff. but limited effect (even not negative)

Confident model but no robust coefficient

NB: All estimations include individual and time-fixed effects ; *** p<0.01, ** p<0.05, * p<0.1 from t-test

Results

2) Average treatment effect on the treated: general "green" intensification indicators / **FIXED CAPITAL**

	Building index		***Equipment index***		***Machine index***	
	-1	-2	-1	-2	-1	-2
RBA	**0.813*** **	**0.453***	**0.962*** **	**0.594** **	**0.364*** **	**0.212**
	(0.177)	(0.236)	(0.185)	(0.246)	(0.127)	(0.145)
l						
ingrgob		0.703		0.774**		0.536**
		(0.452)		(0.333)		(0.252)
lhht		-0.418		-0.448		0.398
		(0.542)		(0.471)		(0.274)
lmen12		0.622		-0.530		-0.178
		(0.566)		(0.374)		(0.240)
lmay60		0.0768		-1.392**		-0.00837
		(0.798)		(0.541)		(0.392)
larea_prop~p		0.767*		1.899***		1.071***
		(0.409)		(0.506)		(0.353)
2012.year		0.354*		0.358*		0.0501
		(0.189)		(0.199)		(0.0974)
_cons	-0.206***	-2.933**	-0.244***	-5.952***	-0.0925***	-3.952***
	(0.0449)	(1.392)	(0.0469)	(1.694)	(0.0324)	(1.122)
N	126	126	126	126	126	126
R-sq	0.184	0.594	0.229	0.619	0.149	0.439

Clear positive effect of RBA on Fixed Capital

NB: All estimations include individual fixed effects ; *** p<0.01, ** p<0.05, * p<0.1 from t-test

Results

2) Average treatment effect on the treated: general "green" intensification indicators / **FOREST COVER**

	Forest area (Ha)		*Scrubland area (Ha)*		*Plantation area (Ha)*	
	-1	-2	-1	-2	-1	-2
RBA	**-7.945**	**-13.00**	**-6.083***	**-2.592**	**0.141***	**-0.0512**
	(6.413)	(8.814)	(3.619)	(6.992)	(0.0707)	(0.194)
lingroff		45.14		6.458		0.664
		(30.66)		(6.118)		(0.444)
ingrgob		4.711		-1.842		0.564*
		(7.650)		(7.488)		(0.317)
lhht		-17.44		2.903		0.170
		(20.74)		(5.268)		(0.274)
lmen12		-1.623		14.32		0.129
		(7.650)		(12.12)		(0.174)
lmay60		-2.962		-6.194		0.385
		(12.37)		(9.068)		(0.370)
larea_prop~p		6.893		2.864		-0.0805
		(7.608)		(4.530)		(0.0820)
2012.year		2.273		-2.223		0.116
		(4.521)		(6.618)		(0.182)
_cons	19.98***	12.96	4.767***	-8.992	0.231***	-0.0251
	(1.629)	(26.80)	(0.919)	(11.26)	(0.0180)	(0.408)
N	126	126	126	126	126	126
R-sq	0.024	0.147	0.047	0.110	0.018	0.201

RBA seems to have a negative effect on Forest and Schrubland area (But not robust coefficient)

(not robust coefficient)

NB: All estimations include individual fixed effects ; *** p<0.01, ** p<0.05, * p<0.1 from t-test

Results

2) Average treatment effect on the treated: general "green" intensification indicators / **LANDSCAPE FRAGMENTATION**

	Number of land use units		***Mean area of land use units***		***Mean area of pasture units***	
	-1	-2	-1	-2	-1	-2
RBA	**5.219*** **	**0.330**	**-3.061** **	**-1.376**	**-1.950** **	**1.893**
	(1.598)	(1.303)	(1.153)	(1.786)	(0.739)	(1.583)
lingroff		14.61**		-0.232		0.125
		(7.282)		(2.186)		(2.010)
ingrgob		2.161		-0.265		-2.046
		(3.994)		(1.778)		(3.104)
lhht		3.069		0.793		1.504
		(2.884)		(2.171)		(2.488)
lmen12		8.444*		6.361		4.773
		(5.015)		(3.890)		(4.488)
lmay60						2.472
		(3.994)		(1.778)		(3.303)
larea_prop~p		15.64***		1.582		-2.605
		(0.898)		(1.369)		(4.284)
2012.year		1.642*		-1.351		-3.260**
		(0.943)		(1.367)		(1.419)
_cons	13.44***	-33.00***	6.347***	0.165	6.517***	13.01
	(0.406)	(5.395)	(0.293)	(4.401)	(0.200)	(13.65)
N	126	126	126	126	126	126
R-sq	0.120	0.458	0.109	0.192	0.055	0.317

RBA seems to increase number of land use unit

RBA seems to reduce land use mean area

(not robust coefficient)

NB: All estimations include individual fixed effects ; *** p<0.01, ** p<0.05, * p<0.1 from t-test

Results

2) Average treatment effect on the treated: general "green" intensification indicators / **LIVESTOCK FARMING INTENSIFICATION**

	Number of livestock units per Ha of pastures	
	-1	-2
RBA	**0.203**	**1.241**
	(0.205)	(0.886)
lingroff		1.594
		(2.393)
ingrgob		0.73*
		(4.683)
lhht		14.66
		(8.103)
lmen12		-4.492
		(3.604)
lmay60		-13.25*
		(7.714)
larea_prop~p		-3.147***
		(0.802)
2012.year		-0.801
		(0.797)
_cons	2.239***	28.75***
	(0.0556)	(10.40)
N	114	99
R-sq	0.001	0.477

No significant coefficient
No effect of RBA

Limits and further steps

- Limits
  - Local studies, complex extrapolation of results for RBA (context specificity)
  - Data collection limits => Impossible to grasp institutional / local factors
  - No possibility to analyze synergy with Eco label (as almost not developed for cattle raising)
- Further steps to refine analysis
  - Analyze capital increase in an aggregated continuous way (value of capital asset stock instead of an index)
  - Analyze substitution between eligible and non eligible investment
  - Evaluate ES effect using practice/ES gridline derived from Risemp project

Conclusion

- RBA do impact the farms assets level (building, equipment, machine)

- We could not conclude on the effect of RBA on specific investments for intensification process (biological assets), nor intensification indicators (forest cover, land fragmentation, or livestock density

- RBA appears more as a subsidy program to increase farmers' capital than a direct and positive incentive program affecting environmental practices adoption (indirect effect) in a perennial ways

- Design of the program should incorporate more performance based approach if wanted to increase environmental efficiency

Thank You

jflecoq@cirad.fr

anais.lamour@etu.udamail.fr